EFFECT OF SUPPLEMENTATION OF FISH MEAL AND COMMERCIALLY AVAILABLE BYPASS AMINO ACIDS ON GROWTH PERFORMANCE OF GROWING MURRAH BUFFALO HEIFERS

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ABSTRACT

The present study attempts to analyze the effect of feeding fish meal and rumen protected amino acids on growth performance of Murrah buffalo heifers. Eighteen Murrah buffalo heifers between one to two year, on the basis of age and weight randomly distributed into three treatment groups each having six heifers. Animals in treatment T_1 (control group), fed with conventional ration, in T_2 (fish meal supplementation by replacing conventional concentrate) and in T_3 (with 10g commercial bypass Lysine per animal per day + 2g commercial bypass Methionine per animal per day) for 90 days. The amount of concentrate mixture was given to each group in such a way that the experimental ration remains iso-proteinaceous. Feed intake during the experimental period was recorded fortnightly for consecutive two days, on the basis of feeds and fodder offered and left over. Body weight of all the heifers was recorded at fortnightly intervals. The results obtained regarding body weight and metabolic body weight of heifers showed no significant difference among the treatments. But daily live weight gain was significantly ($P<0.05$) higher in T_2 and T_3 than that of T_1. Mean value of dry matter intake (kg/day), the dry matter intake per 100 kg body weight and per kg metabolic body weight among treatments show non-significant difference. Feed conversion ratio and feed efficiency were significantly ($P<0.05$) improved in T_2 and T_3 treatments than that of T_1.

***Key words*:** Buffalo, protected amino acid, feed efficiency, growth rate, heifer and fish meal

Introduction

In spite of India's first position as a global milk producer, productivity of our animals is very low (Kishore *et al.,* 2016). Inadequate feed supply is the major constraint in the rearing of dairy animals in our country. As the bovines are mainly fed on crop residues which are poor quality roughages that are low in protein and protein's availability being only 19-20 MMT whereas the requirement is 30 to 35 MMT (Haque and Hossain, 2012). The dietary supplementation of rumen protected protein and amino acids are recommended to support the physiological and productive needs of livestock for amino acids (Ali *et al.,* 2009). In growing ruminants metabolizable protein is used for tissue synthesis however, microbial protein alone is unable to meet metabolizable protein requirement of rapidly growing calves (AFRC, 1993; NRC, 1996**)** therefore, requires the highest intake of crude protein in diet.

Two essential amino acids Lysine (Lys) and Methionine (Met) are limiting amino acids (NRC, 2001). Lys and Met are found in low concentrations in feed protein and it cannot fulfill the animal requirement, secondly microbial protein is also insufficient to meet the animal requirements. So, protected Lys and Met are added in feed to fulfill the deficiency of these amino acids. Ruminally-protected Methionine (RPM) bypasses the ruminal degradation, because of the coating process and enters the small intestine where it can be directly absorbed. Thus, RPM could improve growth and retain N in ruminants.

Meeting the amino acid requirements becomes more crucial during high productivity stages (high milk production or rapid growth for meat production) (Rulquin and Delaby, 1997; Izumi *et al*., 2000). Supplementation of RPM increases the proportion of dietary AA that is absorbed from the intestine (Archibeque *et al*., 2002). Deficiency in Methionine often limits ruminants' growth (Richardson and Hatfield, 1978). Experiments in dairy animals revealed that supplementation of L-Lysine-HCl along with steam flakes corn rations increased microbial protein synthesis and flow of AA to the duodenum (Bernard *et al*., 2004). Loss of proteins as urea has stimulated interest in chemical treatment to reduce ruminal protein degradation and thereby increase the net intestinal absorption of amino acid (Friedman, 1977). Fish meal contains high levels of available Lysine and Methionine which are deficient in plant protein supplements (Lall, 1991). Fishmeal is a high protein and high energy feedstuff made of dried, ground whole fish or fish cuttings with or without oil extraction, varies in protein between 54 - 75% with about 10% fat. Fishmeal (FM) proteins are not degraded extensively in the rumen (Mercer *et al*., 1980), and greater proportion reaching to small intestine for absorption (Zerbini *et al.,* 1988). Fishmeal protein is high in biological value, provides twice the Lysine and four times the Methionine to the small intestine (Blauwiekel *et al*., 1992). The success of any livestock breeding programme depends upon rearing of young stock to breedable age in a shortest possible time (Singh *et al.,* 2015). How a heifer develops into her potential for milk production depends upon how well we raise and manage her (Alam *et al.,* 2012). Nutrition draws the greatest attention because lack of proper nutrition can reduce the reproductive efficiency. There is need to improve the animal production through better feeding and husbandry management at all stage of buffalo life especially at growing stage of heifers. Keeping in view the above facts, the present investigation was conducted

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to explore the effect of rumen protected Lysine and Methionine versus fish meal supplementation on growth performance of Murrah buffalo heifers.

Materials and Methods

The present investigation was conducted at the Buffalo Research Center of Department of Livestock Production Management, College of Veterinary Sciences, Lala Lajpat Rai University of Veterinary and Animal Sciences, Hisar. Prior approval was taken to conduct the present investigation by the Institutional Animal Ethics Committee. Eighteen healthy Murrah buffalo heifers, in the age group of one to two year of age were selected from buffalo farm of the Department of Livestock Production Management. The experimental animals were kept individually under loose housing system, each enclosing with an open area of 16 square meters and a closed area of 13 square meters, divided into two equal half by temporary partition which could allow individual feeding. Experimental shed was located in east-west direction in a row of six pens. All standard managemental practices and bio-security measures were followed throughout the experiment. All the animals were de-wormed and disinfested against ecto-parasites before start of the experiment adopting standard protocol. Prior to start of experiment an adjustment period of 10 days was given to all the buffalo heifers for acclimatization to the new house and feeding regimen.

Eighteen Murrah buffalo heifers of nearly same age and body weight were randomly distributed into three treatment groups each having six buffalo heifers following Completely Randomized Design (CRD) in such a manner that average body weight and age of each experimental group was almost similar. The initial average body weight of buffalo heifers in three treatment groups were 224.33, 223.83 and 223.33 kg, respectively and differences in initial body weight of experimental animals (Murrah heifers) were non-significant. The details of different treatments are as follows:

S. No.	Group	Treatment
1.	T1 (Control)	Seasonal green fodder + wheat straw + conventional concentrate mixture
2.	T_2	Seasonal green fodder + wheat straw + conventional concentrate mixture + fish meal
3.	T_3	Seasonal green fodder + wheat straw + conventional concentrate mixture + 10 g commercial bypass Lysine per animal per day + 2 g commercial bypass Methionine per animal per day

During the experimental period, the animals were given green fodder and concentrates mixture as to meet their protein and energy need for growth as per ICAR (Ranjhan, 1998) feeding standard. The chaffed green fodder sorghum (chaffed size- 2.0 to 2.5 cm) was given at the rate of 8 kg/animal/day along with 1.5 kg/animal/day wheat straw (chaffed size- 1.5 to 2.0 cm). The amount of concentrate mixture was given to each group in such a way that the experimental ration remains iso-proteinaceous. The quantity of different feeds given to each group was adjusted at fortnightly intervals so that the overall DCP requirements of heifers were met according to the change in body weight. Animals were given *ad lib* fresh water throughout the experimental period. Before formulation of rations, the feed ingredients were analyzed (AOAC, 2005) for proximate composition (Table 1). Based upon the proximate composition of feed ingredients, the ration for the different experimental groups of animals was formulated. The composition of the experimental diet of different treatment groups and proximate chemical composition is presented in Table 2. Experimental animals were weighed (kg) just before starting the actual experiment and thereafter at fortnightly intervals using platform weighing balance (AVERY, capacity 1000 kg) installed at animal farm, LUVAS Hisar, to know the body weight. The weights were recorded in the morning before providing feed and water to the animals. The body weights were utilized for computation of ration as well as to know weight gain or growth rate after fortnightly intervals. All the animals were fed roughage and concentrate individually. Feed intake during the experimental period was recorded fortnightly for consecutive two days on the basis of feeds and fodder offered and weigh back. The data obtained were analysed statistically using standard methods (Snedecor and Cochran, 1994). For two way analysis of variance (ANOVA) using general linear model of SPSS version 17 and Duncan's multiple range tests was applied to test the significance. Significance was declared when P value is less than 0.05.

Results and Discussion

Body weight

Average body weight (BW) of all the experimental Murrah buffalo heifers at fortnightly interval showed increasing trend in all the three treatments throughout the experiment and has been presented in Table 3. Initial average body weight of all the treatment groups i.e. T_1, T_2 and T_3 were 224.33, 223.83 & 223.33 kg and at the end of experiment they were 284.50, 294.33 and 292.17 kg, respectively. Average body weight of experimental animals under different treatments at fortnightly intervals did not differ significantly among the treatments. Zinn and Owens (1993) and Dawson *et al.* (1991) revealed similar results on supplementation of fish meal in basal diet of steers, between the control group and the treatment group in terms of average body weight gain. Gajera *et al.* (2013) and Movaliya *et al.* (2012) also reported higher average body weight gain in the groups of growing Jaffrabadi buffalo heifers supplemented with bypass Methionine-Lysine in the ration than that of control. Improvement in body weight due to feeding of fish meal and rumen protected amino acids (Methionine and Lysine) in T_2 and T_3 treatments, respectively might be due to the better availability of protein at absorption site in small intestine as bypass protein escape the rumen and being available for the absorption in the small intestine and helps in better growth of Murrah buffalo heifers.

Metabolic body weight ($KgW^{0.75}$)

Average metabolic BW of Murrah buffalo heifers of all the three treatments were calculated at fortnightly intervals and data has been presented in Table 4. Initial, average metabolic body weights ($Kg\ W^{0.75}$) of experimental heifers were 57.72,

57.57 and 57.48 kg in T_1, T_2 and T_3 groups respectively. Final metabolic body weights at the end of experiment, corresponding groups were 69.09, 70.85 and 70.46 kg respectively. The data did not show any significant difference among the treatments.

Average daily gain (ADG)

Average daily weight gain (g/day) by growing Murrah buffalo heifers under different treatments has been presented in Table 5. After first fifteen days average daily weight gain were 622.22, 677.78 and 666.67 g/d in T_1, T_2 and T_3, respectively. The data did not show any significant increase in average daily weight gain among the different treatments up to 45 days but after 60 days there was significantly higher ($P<0.05$) gain in T_2 treatment which was similar to T_3 as compared to control T_1. The average daily gain then followed similar trend till the end of experiment. Average daily weight gains at the end of experiment, for the corresponding groups were 677.78, 844.44 and 777.78 g/d, respectively. Overall, average daily body weight gain under three treatments during the whole experimental period was 668.51, 783.33 and 764.81 g/d, in T_1, T_2 and T_3 groups, respectively. The overall, average weight gain was significantly ($P<0.05$) higher in T_2 and T_3 treatments as compared to those of T_1. Findings of Zerbini and Polan, (1985) and Davenport *et al.* (1990b) reveal similar results that feeding fish meal as a source of protected amino acids significantly increased average daily weight gain in calves. Similarly Rocha *et al.* (1995) reported that group of Brahman bulls fed with fish meal had significantly higher average daily gain as compared to control group. Alam *et al.* (2012); Ortigues *et al*. (1990) and Calzadilla *et al*. (1992) observed that daily weight gain of heifers was significantly higher when basal diet was supplemented with fish meal. Gajera *et al.* (2013) in the group of Jaffrabadi buffalo heifers and Sai *et al*. (2014) in the group of crossbred calves, reported higher daily weight gain in treatment group supplemented with bypass Methionine and Lysine in the ration over that of control group. Arewad *et al*. (2011) and Vahora *et al*. (2012) also reported the similar pattern of significant ($P<0.05$) improvement in average daily weight gain by supplementing bypass nutrient in treated group over control. In contrast, Belal *et al.* (2008) did not found any effect on growth performance of growing Awassi lambs supplemented with rumen-protected Methionine.

The non-significant results observed by some of the earlier research workers might be due to feeding of different diets and addition of different composition in different ratio or in combination with other nutrients or due to species difference etc. The better growth performance of buffalo heifers on feeding fish meal or protected Methionine and Lysine could be due to the lower degradability of these amino acids in rumen and lower production of NH_3 in rumen, resulting efficient microbial protein synthesis on one hand and a better utilization of dietary nitrogen as amino acid absorbed from the gut on the other side. Feeding protected amino acids served as a good source of higher amount of amino acids for absorption, and leads to proper balance of energy and proteins for better growth performance of heifers supplemented with protected protein.

Feed consumption

Dry matter intake per day (DMI/d)

The overall value of DMI (kg/day/animal) was found to be 6.99, 7.04 and 7.02 in T_1, T_2 and T_3, respectively. Statistical analysis of data revealed that there was no significant difference in the dry matter intake among the different treatments (Table 6). The amount of DMI (kg/day) is very near to the reported value of 6.21 to 6.48 kg/day by Arewad *et al.* (2011) in crossbred calves. Analogous to the present findings, Socha *et al.* (2005); Lara *et al.* (2006); Colin-Schoellen *et al.* (1995) and Lee *et al.* (2012) observed that there was no effect of Lysine and Methionine supplementation on DM intake kg/d in dairy cows. Ahmed *et al.* (2016) also reported no significant difference for DMI between control and treatment groups fed Lysine and Methionine supplemented ration in Nili-Ravi buffaloes. Also, Gajera *et al.* (2013) witnessed the similar results in Jaffrabadi buffalo heifers. Similarly, Sai *et al*. (2014) repoted no differences in average DM intake by supplementation of bypass Methionine and Lysine in the ration of crossbred calves. Arewad *et al*. (2011) and Yadav (1993) observed no significant difference for DMI between control and treatment groups fed bypass protein based ration to calves. Findings of Hussein and Jordan (1991a) in growing finishing lambs and Davenport *et al.* (1990b) in crossbred beef calves reveal similar results i.e. feeding fish meal as a source of protected amino acids did not show any improvement in DMI. The present results are in agreement with most of the findings of earlier researchers. On the basis of present findings it was revalidated that there was no effect of feeding fish meal and protected amino acids on DMI/d in growing Murrah buffalo heifers.

DM intake kg (per/100 kg body weight)

The overall value of dry matter intake in buffalo heifers was 2.89, 2.91 and 2.90 kg per 100 kg body weight in T_1, T_2 and T_3 treatments, respectively (Table 7). The mean value of DMI of % body weight did not show any significant difference between treatments. The value of DMI of % body weight are in close agreements with the reports of Sai *et al*. (2014) in calves, whereas slightly higher than the value reported by Gajera *et al*. (2013) in Jaffrabadi heifers and lower than the value reported in crossbred calves by Arewad *et al.* (2011). Present results are in agreement with the findings of Patel *et al.* (2012) in buffalo heifers, where they did not found significant difference for DM intake (kg/100 kg BW) on feeding of bypass protein. Gajera *et al.* (2013) also found no significant differences for percent dry matter intake in the group of Jaffrabadi buffalo heifers supplementation with bypass Lysine, Methionine and fat than that of control. On the basis of present findings it was revalidated that there was no effect of feeding fish meal and protected amino acids on percent DMI in growing Murrah buffalo heifers.

DM intake (g) per kg metabolic body weight per day

The mean value of DMI per kg metabolic body weight was 113.64, 114.26 and 113.94 (g/kg $W^{0.75}$) for heifers in T_1, T_2 and T_3 treatments, respectively and value did not differ significantly between the treatments (Table 8). Present results are in accordance with the findings of Gajera *et al.* (2013) where they found no significant differences for dry matter intake per kg metabolic weight in the group of Jaffrabadi buffalo heifers supplementation with bypass Lysine, Methionine and fat than that of control. Contrarily to present finding Patel *et al.* (2012) reported significantly ($P<0.05$) improved in the average daily

Table 1: Chemical analysis of feed ingredients (on DM basis)

Ingredients	DM	CP	CF	EE	Ash	OM	NFE
Wheat straw	94.27	1.78	35.31	1.04	12.49	87.51	49.38
Green sorghum	24.92	7.45	26.82	3.4	10.7	90.3	51.63
Wheat	91.61	10.89	2.77	3.15	2.23	97.77	80.96
Barley	93.32	9.55	7.88	1.74	4.96	95.04	75.87
Groundnut cake (GNC)	93.47	40.23	9.43	9.05	8.9	91.1	32.39
Mustard cake	93.46	35.62	8.33	6.25	6.83	93.17	42.97
Fish meal	89.97	45.8	1.81	11.4	27.07	72.93	13.92
Wheat bran	92.86	13.86	11.83	1.01	4.12	95.88	69.18

Table 2: Ingredients of concentrate mixture (kg) and its chemical composition (on DM basis)

S. No	Ingredient	T_1 (kg)	T_2 (kg)	T_3 (kg)
1.	Barley	25	25	25
2.	Wheat	10	12	10
3.	Ground Nut Cake	20	13	20
4.	Mustard Cake	10	10	10
5.	Wheat Bran	32	33.5	32
6.	Fish Meal	0	3.5	0
7.	Bypass Methionine	0	0	*
8.	Bypass Lysine	0	0	**
9.	Mineral Mixture	2	2	2
10.	Salt	1	1	1
	Total	100	100	100
* supplemented @ 2 g/ animal/day **supplemented @ 10 g/ animal/day				
Chemical composition (% DM basis)				
1.	Dry matter (DM)	90.46	90.17	90.67
2.	Crude protein (CP)	24.51	24.88	24.66
3.	Crude fiber (CF)	6.31	6.49	6.12
4.	Ether extract (EE)	5.07	5.02	5.59
5.	Ash	7.41	7.77	7.91
6.	Organic matter (OM)	92.59	92.23	92.09
7.	NFE	55.70	55.84	55.72

DMI on metabolic body weight basis in buffalo calves as a result of feeding concentrate mixture with bypass protein than without bypass protein. In the present study, there was no improvement in dry matter intake on metabolic body weight basis in Murrah buffalo heifers by feeding fish meal and rumen protected amino acids. The significant improvement results observed by some of the earlier research workers might be due to feeding of different diets and addition of different composition in different ratio or in combination with other nutrients etc.

Feed efficiency

Feed conversion ratio (DMI per kg weight gain)

The results of present study showed that the FCR i.e. DMI required per kg body weight gain by heifers ranged from 10.86 to 11.83, 10.86 to 9.48 and 9.63 to 10.26 in T_1, T_2 and T_3 treatments, respectively (Table 9). The data indicated that the difference between the treatments were statistically significant ($P<0.05$) and heifers supplemented with fish meal and protected Methionine and Lysine i.e. T_2 and T_3 treatments required less DM per kg gain in weight in comparison to heifers fed normal ration. Present findings are in agreement with the previous findings of Sai *et al*.(2014) where they reported that percent feed efficiency in crossbred calves was higher ($P<0.05$) in treatment group supplemented with bypass Methionine and Lysine in the ration over that of control group. Yadav (1993) found that requirement of DM per kg gain was less by the

Table 3: Average body weight (kg) of Murrah heifers at fortnightly interval during experiment

Fortnight	Treatments		
	T_1	T_2	T_3
0	224.33 ±20.95	223.83 ±22.74	223.33 ±22.47
1	233.67 ±20.86	234.00 ±22.03	233.33 ±21.89
2	243.33 ±20.01	245.00 ±21.67	245.17 ±21.59
3	254.50 ±19.97	257.00 ±21.85	257.00 ±21.44
4	264.33 ±20.46	269.17 ±22.04	268.67 ±21.92
5	274.33 ±20.79	281.67 ±22.68	280.50 ±22.38
6	284.50 ±21.33	294.33 ±23.04	292.17 ±22.82

Values are means ±standard errors

Table 4: Average metabolic body weight (kg) of experimental Murrah heifers at fortnightly interval during experiment trail

Fortnight	Treatments		
	T_1	T_2	T_3
0	57.72 ±4.08	57.57 ±4.47	57.48 ±4.42
1	59.54 ±4.01	59.57 ±4.29	59.44 ±4.25
2	61.41 ±3.80	61.69 ±4.17	61.72 ±4.13
3	63.53 ±3.75	63.96 ±4.15	63.97 ±4.05
4	65.37 ±3.80	66.24 ±4.13	66.15 ±4.09
5	67.23 ±3.82	68.54 ±4.20	68.33 ±4.13
6	69.09 ±3.89	70.85 ±4.21	70.46 ±4.17

Values are means ±standard errors

female Murrah buffalo calves by feeding of yeast culture fortified with protected protein (Nutri-Sacc). Similarly, Arewad *et al.* (2011) reported significantly difference for feed conversion efficiency in terms of DMI in the groups supplemented with rumen protected protein based total mixed ration (TMR) compared to control. Addition of FM to the diets of beef calves increased feed efficiency when compared to control diets (Davenport *et al.,* 1990b). Zinn and Owens, (1993) reported, increased feed efficiency by incorporation of FM in the ration of steers. The present results are in agreement with most of the findings of earlier researchers and suggest that feeding of fish meal and rumen protected Methionine and Lysine to Murrah buffalo heifers have significant effect on feed conversion ratio. The possible reason may be improved nutrient absorption, efficient gut micro-flora and better digestibility in fish meal and rumen protected Methionine and Lysine.

Feed conversion efficiency (FCE)

The results of present study showed that the FCE values of T_2 and T_3 treatments was significantly differ ($P<0.05$) from T_1

Table 5: Average daily body weight gain (g) of experimental Murrah heifers at fortnightly intervals

Fortnight	Treatments		
	T_1	T_2	T_3
1	622.22 ±88.89	677.78 ±150.47	666.67 ±62.06
2	644.44 ±99.88	733.33 ±66.67	788.89 ±58.16
3	744.44 ±52.82	800.00 ±51.64	788.89 ±31.82
4	655.56^{b} ±52.82	811.11^{a} ±40.06	777.78^{ab} ±37.18
5	666.67^{b} ±45.54	833.33^{a} ±50.52	788.89^{ab} ±43.60
6	677.78^{b} ±40.06	844.44^{a} ±32.96	777.78^{ab} ±32.96
Over all	668.51^{b} ±26.22	783.33^{a} ±30.55	764.81^{a} ±18.87

Values are means ±standard errors The means in a row with different superscripts differ significantly between the treatments (P<0.05)

Table 6: Average dry matter intake (kg/day) of experimental Murrah heifers at fortnightly intervals

Fortnight	Treatments		
	T_1	T_2	T_3
1	6.09 ±0.02	6.12 ±0.04	6.13 ±0.06
2	6.34 ±0.04	6.36 ±0.04	6.35 ±0.04
3	6.82 ±0.06	6.84 ±0.06	6.83 ±0.06
4	7.13 ±0.10	7.19 ±0.06	7.17 ±0.09
5	7.67 ±0.05	7.79 ±0.02	7.76 ±0.07
6	7.89 ±0.05	7.95 ±0.06	7.92 ±0.03
Over all	6.99 ±0.11	7.04 ±0.11	7.02 ±0.11

Values are means ±standard errors

(Table 10). Similar effect on feed conversion efficiency (%) for growth (unit gain/unit DM consumed X 100) was reported by Zinn and Owens, (1993) in a growth trial on steers, that by incorporation of FM in the ration, efficiency of gain increased. Sai *et al*. (2014) reported higher (P<0.05) feed efficiency in treatment group supplemented with bypass Methionine and Lysine in the ration over that of control group in crossbred calves. Present study suggested that feeding of fish meal and rumen protected Methionine and Lysine to Murrah buffalo heifers have significant effect on feed conversion efficiency and in agreement to many earlier findings. The possible reason may be improved nutrient absorption, efficient gut micro-flora and better digestibility in fish meal and rumen protected Methionine and Lysine fed groups.

Table 7: Average dry matter intake (kg) per 100 kg body weight of experimental Murrah heifers

Fortnight	Treatments		
	T_1	T_2	T_3
1	2.84 ± 0.28	2.89 ± 0.32	2.89 ± 0.30
2	2.82 ± 0.24	2.85 ± 0.29	2.85 ± 0.27
3	2.89 ± 0.22	2.91 ± 0.27	2.89 ± 0.25
4	2.87 ± 0.19	2.91 ± 0.25	2.88 ± 0.22
5	2.98 ± 0.21	3.01 ± 0.27	2.99 ± 0.24
6	2.95 ± 0.21	2.92 ± 0.24	2.91 ± 0.23
Over all	2.89 ± 0.08	2.91 ± 0.10	2.90 ± 0.09

Values are means ±standard errors

Table 8: Average dry matter intake (g) per kg $W^{0.75}$ of experimental Murrah heifers at fortnightly interval.

Fortnight	Treatments		
	T_1	T_2	T_3
1	108.28 ± 7.76	109.59 ± 8.72	109.72 ± 8.18
2	108.74 ± 6.84	109.59 ± 8.10	109.60 ± 7.61
3	112.93 ± 6.14	113.30 ± 7.48	112.94 ± 6.94
4	113.73 ± 5.34	114.78 ± 7.15	114.00 ± 6.19
5	119.15 ± 6.23	120.16 ± 8.04	119.48 ± 7.00
6	119.04 ± 6.11	118.16 ± 7.04	117.89 ± 6.66
Over all	113.64 ± 2.54	114.26 ± 3.01	113.94 ± 2.76

Values are means ±standard errors

Table 9: Mean feed conversion ratio (DMI/kg body weight gain) of experimental Murrah heifers at fortnightly interval.

Fortnight	Treatments		
	T_1	T_2	T_3
1	10.86 ± 1.53	10.86 ± 1.53	9.63 ± 0.96
2	11.06 ± 1.67	9.09 ± 0.94	8.35 ± 0.80
3	9.38 ± 0.62	8.72 ± 0.56	8.74 ± 0.42
4	11.17^{a} ± 0.77	8.98^{b} ± 0.46	9.29^{b} ± 0.33
5	11.75^{a} ± 0.72	9.41^{b} ± 0.53	9.88^{b} ± 0.53
6	11.83^{a} ± 0.68	9.48^{b} ± 0.34	10.26^{b} ± 0.38

Values are means ±standard errors. The means in a row with different superscripts differ significantly between the treatments (P<0.05)

Table 10: Feed conversion efficiency (BW gain g/kg DMI) of experimental Murrah heifers at fortnightly interval

Fortnight	Treatments		
	T_1	T_2	T_3
1	10.21 ± 1.46	11.11 ± 2.50	10.90 ± 1.07
2	10.20 ± 1.63	11.55 ± 1.07	12.43 ± 0.94
3	10.91 ± 0.76	11.71 ± 0.75	11.57 ± 0.52
4	9.18^{b} ± 0.66	11.27^{a} ± 0.53	10.83^{a} ± 0.40
5	8.68^{b} ± 0.57	10.79^{a} ± 0.60	10.27^{a} ± 0.54
6	8.58^{b} ± 0.46	10.61^{a} ± 0.36	9.81^{a} ± 0.36

Values are means ± standard errors. The means in a row with different superscripts differ significantly between the treatments (P<0.05)

References

AFRC (1993) Agricultural and Food Research Council. Energy and protein requirements of ruminants. CAB International, Wallingford, UK.

Ahmed S, Gohar M, Khalique A, Ahmad N, Shahzad F, Azam B, Rahman A and Khan MI (2016) Effect of supplementation of rumen protected lysine and methionine on production performance, milk and blood parameters of early lactating nili-ravi buffaloes. *Pakistan J. Zool.* **48**(2): 359-363.

Alam MS, Rashi MH, Uddin ME and Asaduzzaman M (2012) Effect of supplementation of fish meal on growth and reproductive performance of crossbred heifers. *J. Bangladesh Agri. Univ.* **10**(2): 261–266.

Ali CS, Islam-ud-din, Sharif M, Nisa M, Javaid A, Hashmi N and Sarwar M (2009) Supplementation of ruminally protected proteins and amino acids: feed consumption, digestion and

performance of cattle and sheep. Int. *J. Agr. Bio.* **11**(4): 477–482.

AOAC (2005) Official methods of analysis, 18th ed. Association of official analytical chemists. Gaithersburg, Maryland, USA.

Archibeque SI, Burns JC and Huntington GB (2002) Nitrogen metabolism of beef steers fed endophyte-free tall fescue hay: Effect of ruminally protected methionine supplementation. *J. Anim. Sci.* **80**: 1344–1351.

Arewad GR, Thube HA, Pandya PR, Parnerkar S and Shankhpal S (2011) Effect of feeding bypass protein based total mixed ration on Performance of growing crossbred calves. *Indian J. Anim. Nutr.* **28**(3): 303-308.

Belal S, Obeidat AY, Abdullah MS, Awawdeh RT, Kridli HHT and Rasha IQ (2008) Effect of Methionine supplementation on performance and carcass characteristics of Awassi ram lambs fed finishing diets. *Asian-Aust. J. Anim. Sci*. **21**(6):831-837.

Bernard JK, Chandler PT, West JW, Parks AH, Amos HA, Froetschel MA and Trammell DS (2004) Effect of supplemental L Lysine–HCl and corn source on rumen fermentation amino acid follows to the small intestine. *J. Dairy Sci.* **87**: 399–405.

Blauwiekel R, Xu S and Harrison JH (1992) The use of cereal grains and by-product feeds to meet the amino acid requirements of dairy cattle. In: Proc. 27th Pacific Northwest Animal Nutrition Conf. Spokane, WA. pp: 225-236.

Calzadilla O, Rattia A and Combellas J (1992) Nitroen supplementation of maize and sorghum silage for growing cattle. Addition of fish meal. *Revista-de-la-facultad-de-Agronomia,-Universidad-Central-de-Venezuela***. 18**: 201.

Colin-Schoellen O, Laurent F, Vignon B, Robert JC and Sloan B (1995) Effect of ruminaly protected lysine and methionine with protein or energy level in diets of cows. *J. Dairy Sci*. **78**: 2807-2818.

Davenport GM, Boling JA and Gay N (1990b) Performance and plasma amino acids of growing calves fed corn silage supplemented with ground soybeans, fishmeal, and rumen-protected Lysine. *J. Anim. Sci.* **68**: 3773-3779.

Dawson JM, Buttery PJ, Lammiman MJ, Soar JB, Essex CP, Gill M and Beever DE (1991) Nutritional and endocrinological manipulation of lean deposition in forage-fed steers. *Br. J. Nutr.* **66**: 171-185.

Friedman M (1977) Protein Cross linking, Springer Science and business Media, New York, pp: 545.

Gajera AP, Dutta KS, Savsani HH, Parsana Vataliya PH, Sipai SH, Ribadiya NK (2013) Effect of rumen protected lysine, methionine and fat on nutrients utilization in growing Jaffrabadi heifers. *Indian J. Anim. Nutr.* **30**(4): 351-357.

Haque N and Hossain A (2012) Concepts of bypass protein feeding in ruminants. *Livestock Line* pp: 9-13.

Hussein HS and Jordan RM (1991a) Fish meal as a protein supplement in finishing lamb diets. *J. Anim. Sci*. **69**: 2115-2122.

Izumi K, Kikuchi C and Okamoto M (2000) Effect of rumen protected methionine on lactational performance of dairy cows. *Asian-Aust. J. Anim. Sci.* **13**: 1235-1238.

Kishore K, Joshi RK, Kumar P and Pal RS (2016) Genetic and non-genetic factors affecting some production traits in Tharparkar cattle. *Vet. Pract.* **17**(1): 38-40.

Lall SP (1991) Digestibility, metabolism and excretion of dietary phosphorus by fish. In: Cowey CB and Cho CY (eds). In proceedings of First international symposium on nutritional strategies in management of aquaculture waste, University of Guelph, Canada. pp: 275.

Lara A, Mendoza GD, Landois L, Barcena R, Saanchez MT, Rojo R, Ayala J and Vaga S, (2006) Milk production in Holstein cows using different levels of ruminaly protected methionine. *Livest. Sci*. **105**: 105-108.

Lee C, Hristov AN, Cassidy TW, Heyler KS, Lapierre H, Varga GA, Veth MJ, Patton RA and Parys C (2012) Rumen-protected Lysine, methionine, and histidine increase milk protein yield in dairy cows fed a metabolizable protein-deficient diet. *J. Dairy Sci*. **95**: 6042-6056.

Mercer JR, Allen SA and Miller EL (1980) Rumen bacterial protein synthesis and the proportion of dietary protein escaping degradation in the rumen of sheep. *Br. J. Nutr*. **43**: 421.

Movaliya JK (2012) Effect of rumen bypass methionone and lysine supplementation on performance of Jaffrabadi heifers. M.V.Sc. Thesis submitted to Junagadh Agricultural University, Junagadh, India.

National Research Council (1996) Nutrient requirements of beef cattle (7th ed.). National Academy Press, Washington, DC.

National Research Council (2001) Nutrient requirements of dairy cattle. (7th revised ed.). National Academy Press, Washington, DC.

Ortigues I, Smith T, Gill M, Cammell SB and Yarrow NW (1990) The effect of fish meal supplementation of a straw-based diet on growth and calorimetric efficiency of growth in heifers. *Br. J. Nutr*. **64**(3): 639-51.

Patel VR, Gupta RS and Jani VR (2012) Effect of feeding bypass protein on growth, body measurements and nutrient utilization in growing buffalo heifers: a field trial. *Indian J. Anim. Nutr.* **29**(2): 152-156.

Ranjhan SK (1998) Nutritional Requirement of Livestock and Poultry. 2nd Revised edn., Indian Council of Agricultural Research. Krishi Anusandhan Bhavan, Pusa, New Delhi.

Richardson CR and Hatfield EE (1978) The limiting amino acids in growing cattle. *J. Anim. Sci.* **46**: 740-745.

Rocha A, Carpena M, Triplett B, Forrest DW and Randel RD (1995) Effect of ruminally undegradable protein from fish meal on growth and reproduction of peripuberal brahman bulls. *J. Anim. Sci.* **73**:947-953.

Rulquin H and Delaby L (1997) Effects of the energy balance of dairy cows on lactational responses to rumen-protected Methionine. *J. Dairy Sci.* **80**: 2513-2522.

Sai S, Thakur SS, Kewalramani N, Chaurasia M (2014) Effect of supplementation of rumen protected methionine plus lysine on growth performance, nutrient utilization and blood metabolites in calves. *Indian J. Anim. Nutr.* **31**(1): 1-7.

Singh ST, Dua K, Sharma S and Mahajan V (2015) Risk factors associated with the incidence of diarrhea in buffalo and cattle calves. *Vet. Pract.* **16**(2): 294-296.

Snedecor GW and Cochran WG (1994) Statistical Methode. 8th ed., Oxford and IBH Publishing Co., New Delhi.

Vahora SG, Parnerkar S and Kore KB (2012) Effect of feeding bypass nutrients to growing buffalo heifers under field conditions. *Livest. Res. Rural Dev.* **24**(2). Retrieved from http://www.lrrd.org/lrrd24/2/vaho24024.htm.

Yadav MS (1993) Effect of commercial yeast culture supplementation in the diet of female buffalo calves on growth and feed conversion efficiency. Ph.D. Thesis submitted to Haryana Agricultural University Hisar.

Zerbini E and Polan CE (1985) Protein sources evaluated for ruminating Holstein calves. *J. Dairy Sci.* **68**: 1416–1424.

Zinn RA and Owens FN (1993) Ruminal escape protein for live weight fed lot calves. *J. Anim. Sci.* **71**: 1677.